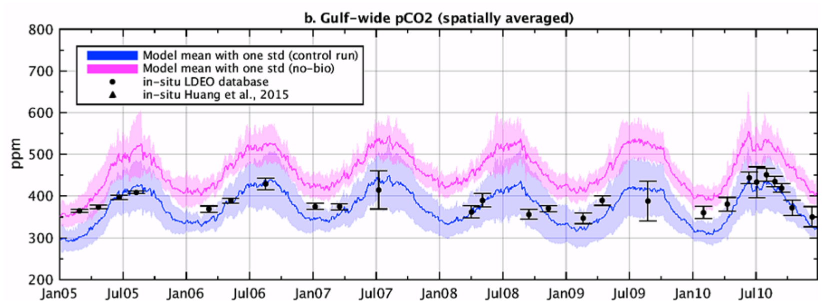
Modeling pCO_2 variability in the Gulf of Mexico

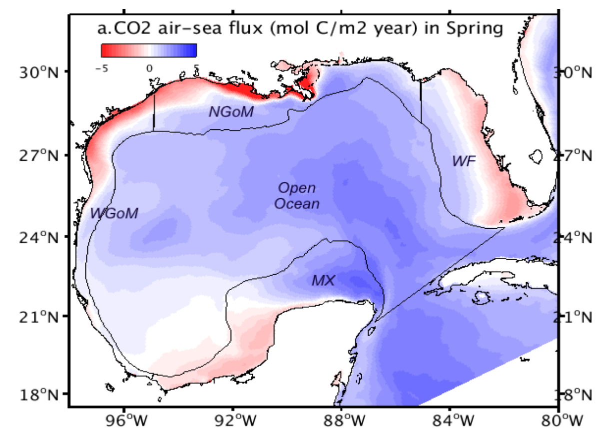
Challenge: Oceans act as receivers of large carbon loading from terrestrial run-off and as vast carbon reservoirs via the ocean "carbon pump." Thus, a better understanding of the oceans' role in regulating the global carbon cycle is crucial. Our objectives were to 1) produce model simulations of CO_2 flux at the air–sea interface in the Gulf of Mexico - current estimates are based largely on observational analyses and subject to large uncertainty; and 2) constrain the relationship between CO_2 fluxes, river plume dynamics, and dominant oceanic processes.

Methods: A three-dimensional coupled physical–biogeochemical model was used to simulate and examine temporal and spatial variability of sea surface partial pressure of CO_2 (pCO_2) in the Gulf of Mexico. The model was driven by realistic atmospheric forcing and observed freshwater and terrestrial nutrient and carbon input from major rivers to produce a multi-year model hindcast (2005-2010). NASA and other satellite data (MODIS, AVISO) were used in the tuning and validation of the model (see also Xue et al., 2013, *Biogeosciences,* 10, 7219–7234).



Model simulated time-series of spatially averaged pCO^2 in the Gulf of Mexico, overlaid with in situ observations (in black). Control run (in blue) included all processes, and no-biology run (in magenta) included only physical and chemical effects.

Key Findings: Model results revealed seasonality in surface pCO_2 and showed that, despite spatial and temporal variability, the Gulf of Mexico was a net CO_2 sink, with a flux of 1.11 $\pm$ 0.84 x 10^{12} mol C yr^{-1}. This is comparable to estimated inorganic carbon export through the Loop Current.



Six-year (2005–2010) model mean air–sea CO_2 flux in the Gulf of Mexico during spring. Blue indicates ocean is a sink for CO_2; red a source.

Significance: This is the first comprehensive physical-biogeochemical coupled model simulation of air-sea flux of CO^2 in the Gulf of Mexico. The findings highlight the role of biological uptake as an important driver for the CO^2 sink and provide critical information for North American and global carbon budgets.

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